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Digestion—the Conversion of Feed to Pork

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The digestive system of the pig might be compared to an assembly line in a factory. As feed (the raw materials) passes from the feed trough along this "assembly line", it is converted into a form of nutrients that can be absorbed and later used for body functions.

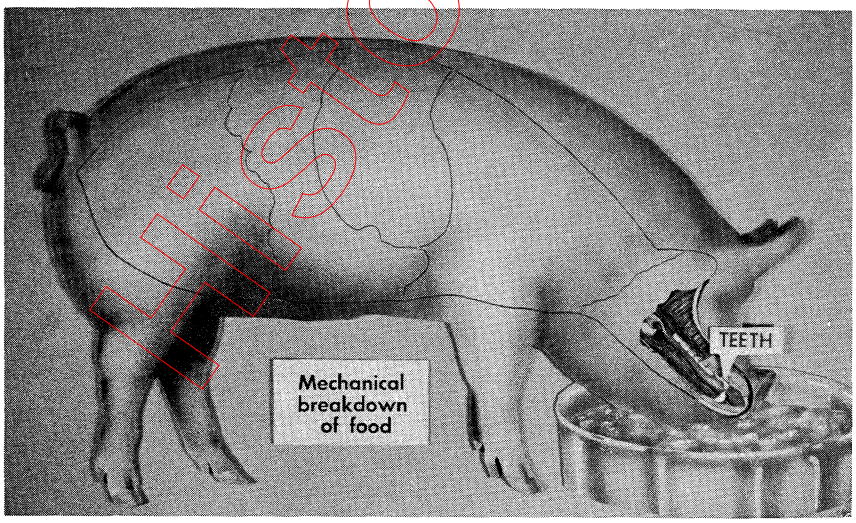
Digestion includes the physical and chemical changes feed undergoes as it passes through the digestive tract. This tract includes the mouth, esophagus, stomach, small intestine and large intestine. One might consider the digestive tract as being a continuous tube with the body constructed around it.

The purpose of the digestive system is to reduce chemically-complex nutrients (carbohydrates, fats and proteins) to small units (simple sugars, fatty acids and amino acids) that can be absorbed through the intestinal wall. This reduction is accomplished by both physical and chemical processes.

What are the practical applications that can be made from a study of the digestive system? Research has shown that pigs convert feed more efficiently when the feed is ground relatively fine, as compared to a coarse grind. This can be partially explained by the fact that the more finely-ground feed offers more surface area on which the digestive enzymes can act.

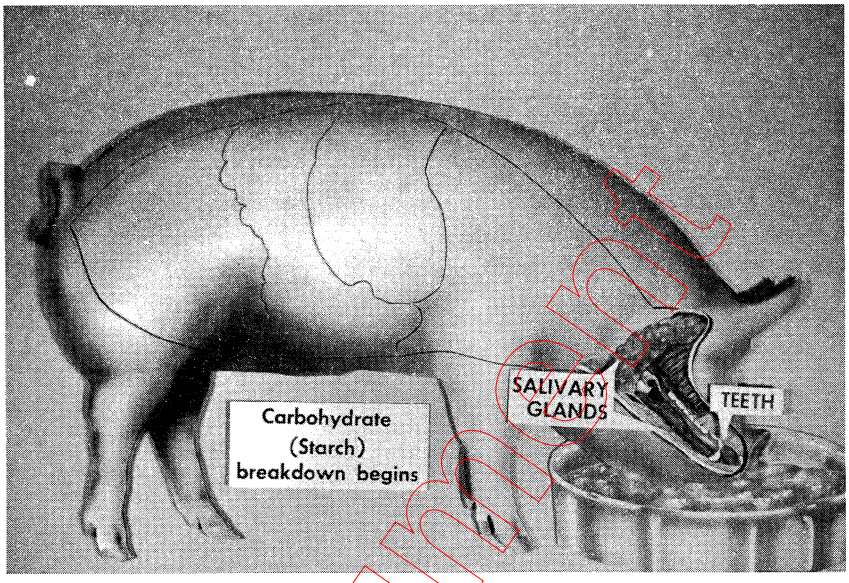
The matter of enzyme digestion is also the reason why an unhealthy pig is an inefficient converter of feed. Passage of food through the pig's digestive system normally requires 36 to 48 hours. Where disease level is high and pigs are scouring, the rate of food passage is much faster. This means the enzymes have less opportunity to break down nutrients for absorption, and much of the food passes through the tract undigested.

Following is a sequence of illustrations that traces the food as it passes through the digestive tract. The picture captions explain the changes taking place in each segment of the tract.

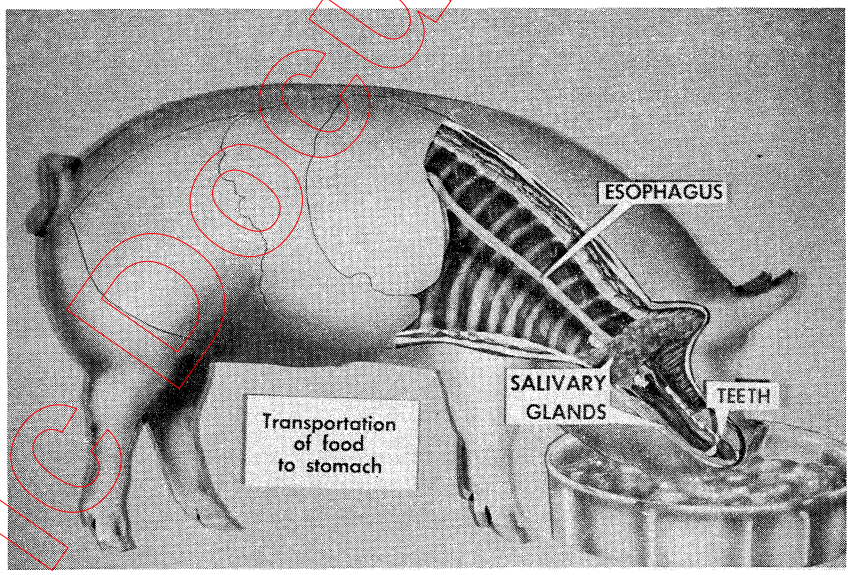


1. Teeth. Digestion of feed starts in the mouth with mechanical breakdown by the teeth. This chewing and grinding action of the teeth serves to increase the surface area of food particles. The increased surface area permits more efficient chemical digestion by enzymes in the mouth, stomach and small intestine. Movements by the tongue, and later the act of swallowing, also contribute to mechanical breakdown of food. The tongue acts as a plunger driving the food toward the esophagus.

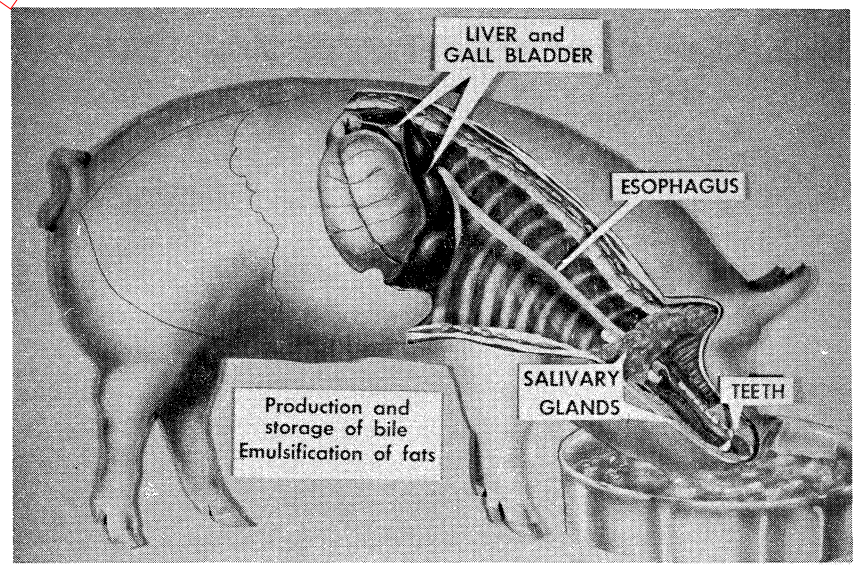
2. Salivary Glands. There are three pairs of salivary glands in the pig's mouth which produce a mixed secretion known as saliva. Saliva contains an amylolytic enzyme, ptyalin, that initiates the breakdown of carbohydrates (starch). This initial phase of carbohydrate digestion occurring in the mouth is not complete; however, a few simple sugars may be released, giving a sweet sensation with certain foods. Chief function of saliva is to serve as a lubricant to moisten the food, which allows swallowing of dry feed. Saliva may be produced even before feed enters the pig's mouth, triggered by sounds from an automatic feeding system.

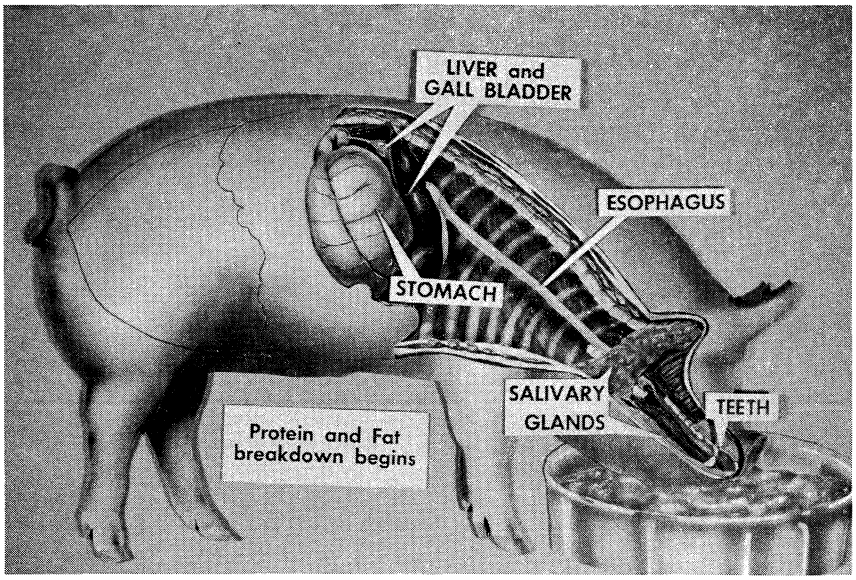


3. Esophagus. The esophagus is a tube leading from the mouth to the stomach, its sole purpose being to provide a passageway for food. The food is moved through the esophagus toward the stomach by peristaltic waves. No enzymes are produced in the esophagus. However, the saliva that was mixed with the food in the mouth contained some carbohydrate-digesting enzymes; therefore, some digestion occurs as the food passes through the esophagus. The opening of the esophagus into the stomach is known as the cardia and is closed by the cardiac sphincter. The sphincter prevents passage of food from the stomach back into the esophagus.

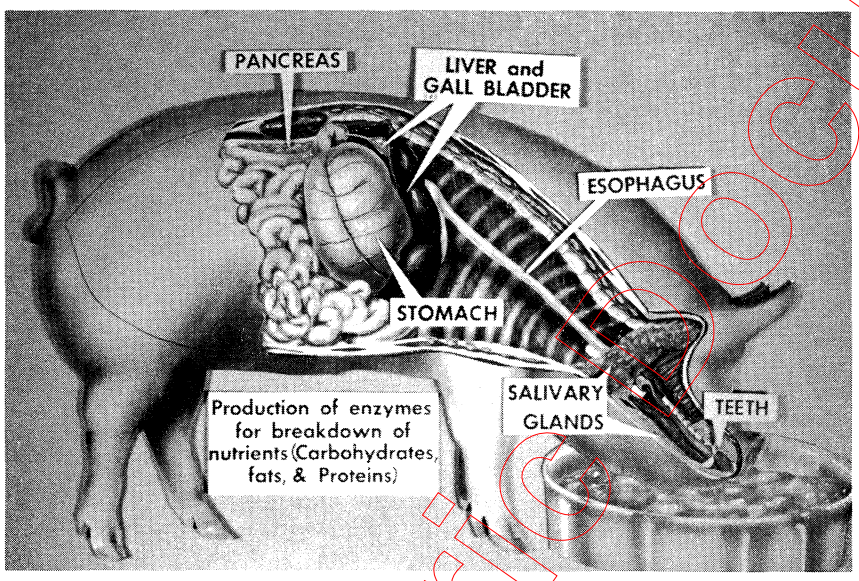


4. Liver and Gallbladder. The liver is the largest gland in the body and has many important functions. One of these functions is concerned with digestion, namely, the secretion of bile. The gallbladder may act as a storage bag for bile. In the pig, the gallbladder has a pressure-regulating function, acting as an elastic bag in a system of relatively inelastic tubes. This action minimizes extreme variations of pressure in the system of biliary ducts. Bile aids the digestion and absorption of fat by assisting in fat emulsification, activating pancreatic lipase, and increasing the solubility of fatty acids.

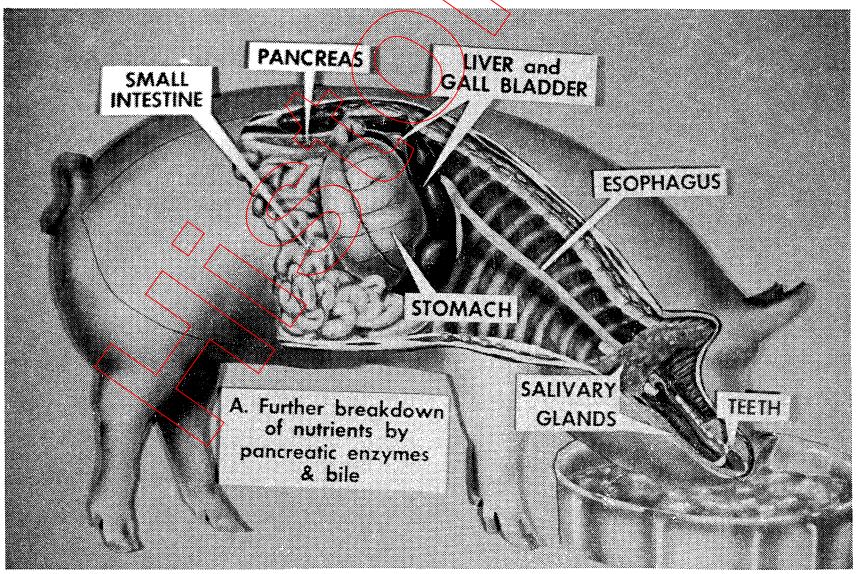




5. Stomach. Presence of food in the stomach stimulates production of hydrochloric acid. Salt (sodium chloride) in the ration furnishes the chlorine which combines with hydrogen to form this hydrochloric acid. The acid stops the action of the salivary enzymes and converts pepsinogen, which is produced in the stomach lining, into the protein-digesting enzyme pepsin. This enzyme initiates the breakdown of protein. Although the main digestion taking place in the stomach is that of protein, there is, perhaps, some fat digestion occurring. The fat-digesting enzyme is gastric lipase. In addition to being an organ in which important factors of digestion operate, the stomach serves as a reservoir for swallowed food. Stomach capacity of a 200-pound hog is approximately 2 gallons.

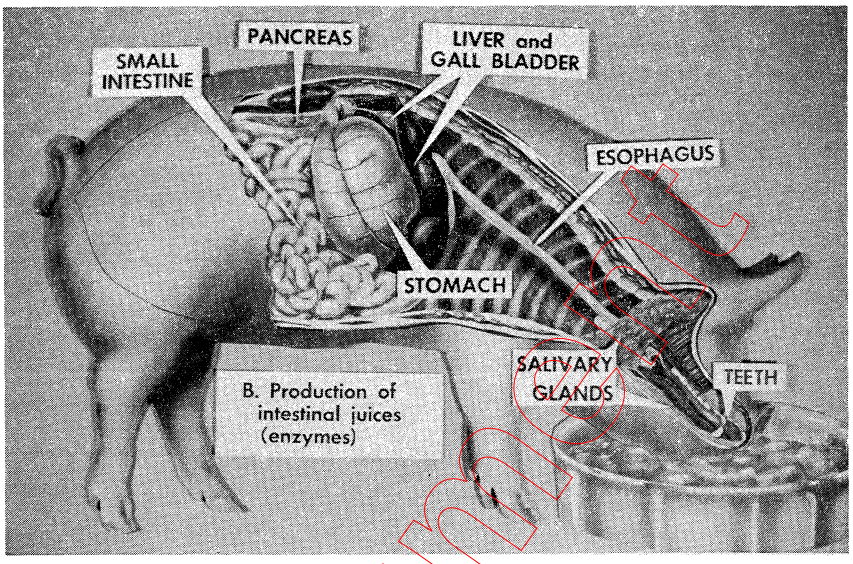


6. Pancreas. The pancreas is similar in structure to certain of the salivary glands already discussed. The pancreas produces a secretion, pancreatic juice, which contains three proteolytic (protein-digesting) enzymes, a lipolytic (fat-digesting) enzyme and an amylolytic (carbohydrate-digesting) enzyme. The pancreas, located between the folds of the small intestine, empties its secretion into the intestine through the pancreatic duct. The proteolytic enzymes present in pancreatic juice include trypsin, chymotrypsin and carboxypeptidase. The fat-digesting enzyme is termed pancreatic lipase or steapsin, and the carbohydrate-digesting enzyme is pancreatic amylase.

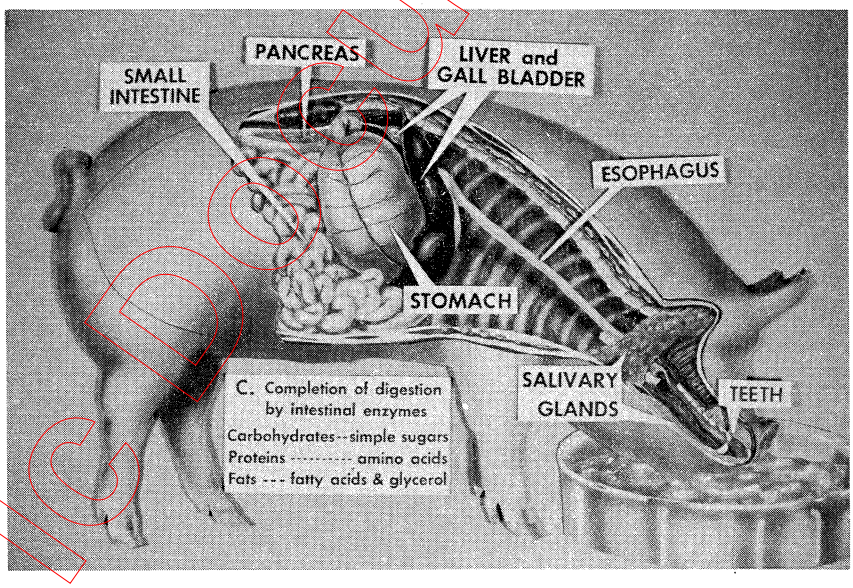


7. Small Intestine (A). Several factors of digestion and absorption of nutrients are associated with the small intestine. Material leaving the stomach and entering the intestine is known as chyme. Its consistency is fluid or semi-fluid. Two of the factors of digestion in the small intestine are the pancreatic juice from the pancreas and the bile from the liver and gallbladder. The enzymes in the pancreatic juice continue the step-wise degradation of carbohydrates, fats and proteins. The small intestine in a hog is approximately 60 feet long and has a capacity of about 2½ gallons.

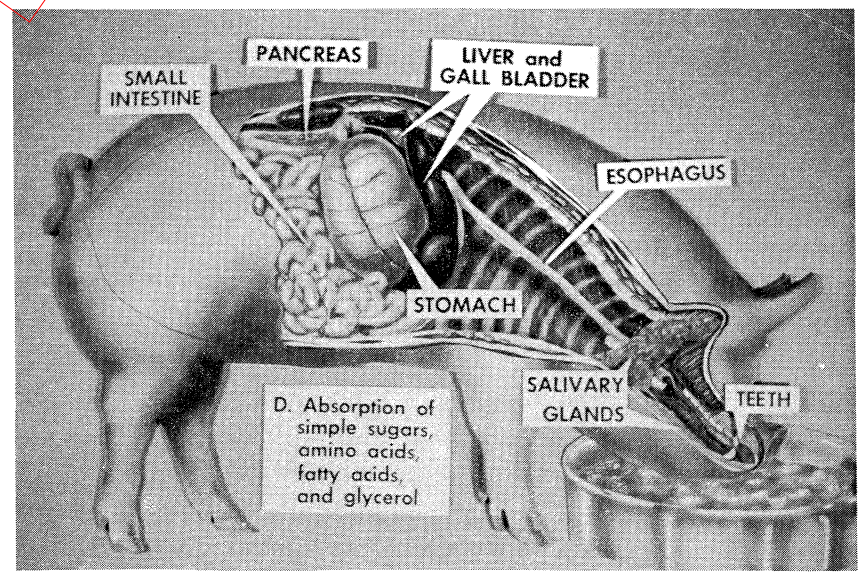
8. Small Intestine (B). Another factor of digestion associated with the small intestine is the production of intestinal juices which contain enzymes. The enzymes found in intestinal juices aid in furthering the breakdown of carbohydrates, fats and proteins. Some of these enzymes probably exert some action on foods during absorption through the intestinal wall.

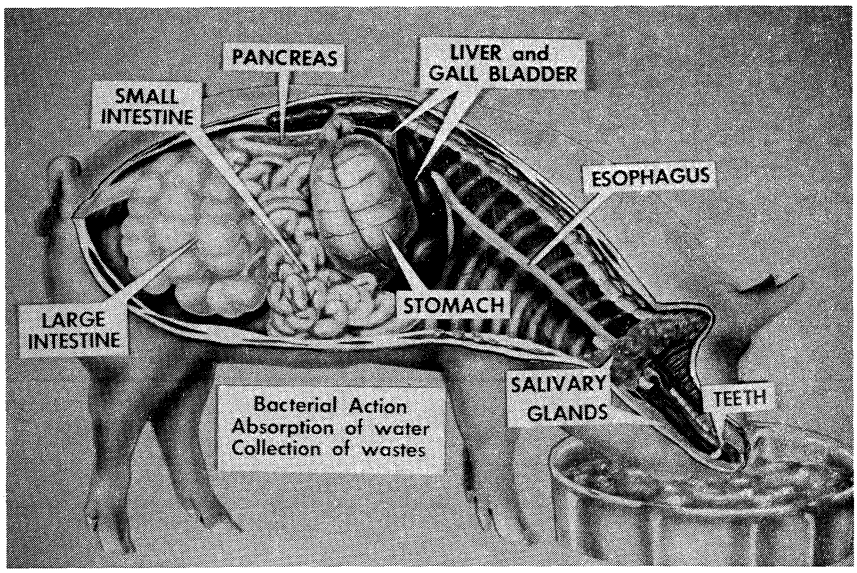


9. Small Intestine (C). The chief function of the digestive system is to break down nutrients to small enough units that they might be absorbed by passing through the intestinal wall. This goal is reached when carbohydrates are broken down to simple sugars such as glucose, when fats are broken down to fatty acids such as linoleic acid, and when proteins are broken down to amino acids such as methionine. The nutrients are of no value to the pig until they are broken down into these extremely small particles so they can be absorbed through the intestinal wall.



10. Small Intestine (D). The ultimate goal in the process of digestion is absorption. This is the process whereby foods, properly prepared by the organs of digestion, are transferred from the digestive tract to the blood or lymph. By means of the blood, the absorbed sugars, amino acids and fatty acids are transported to the tissues for utilization or for storage. Most of the absorption takes place in the small intestine. The intestinal wall has many tiny fingerlike projections known as villi. These villi increase considerably the surface, or absorptive area of the intestine.





11. Large Intestine. The large intestine collects materials that have escaped absorption previously. The digestive processes are practically complete in the small intestine. The environment in the large intestine is such that bacteria multiply easily. Bacterial action may result in some synthesis of certain vitamins. However, the main functions of the large intestine in the pig are to return water from the digestive glands to the blood, and to act as a reservoir for the waste materials that constitute the feces. The large intestine in a hog is approximately 15 feet long and has a capacity of slightly more than 2 gallons.

Summary

The digestive system represents an amazing and incredibly precise "machine". When operating in a healthy hog, it will convert a high energy, properly-balanced ration to pork very efficiently. Under normal conditions, approximately 75 to 80 percent of the carbohydrate, protein and fat in a swine ration will be digested.

A typical swine ration contains approximately 70 percent carbohydrate, 14 percent protein and 3 percent fat. Enzymatic digestion of carbohydrate—the most plentiful nutrient—begins in the mouth; protein digestion begins in the stomach; and the food reaches the small intestine before a significant amount of fat digestion occurs.

Three factors combine to make the swine digestive system work efficiently—quality breeding stock, good herd health and a well-balanced ration. None can be ignored without adversely affecting rate of conversion of feed to pork—and profits!

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